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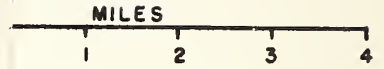


The San Jacinto Experimental Forest

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EXPERIMENTAL
PLOTS

Four Notch Tower

SAN JACINTO
EXPERIMENTAL
FOREST

Winners

Boswell

Cr.

Gourd

Cr.

76

PJ 2-55

GENERAL LOCATION OF SAN JACINTO EXPERIMENTAL FOREST.

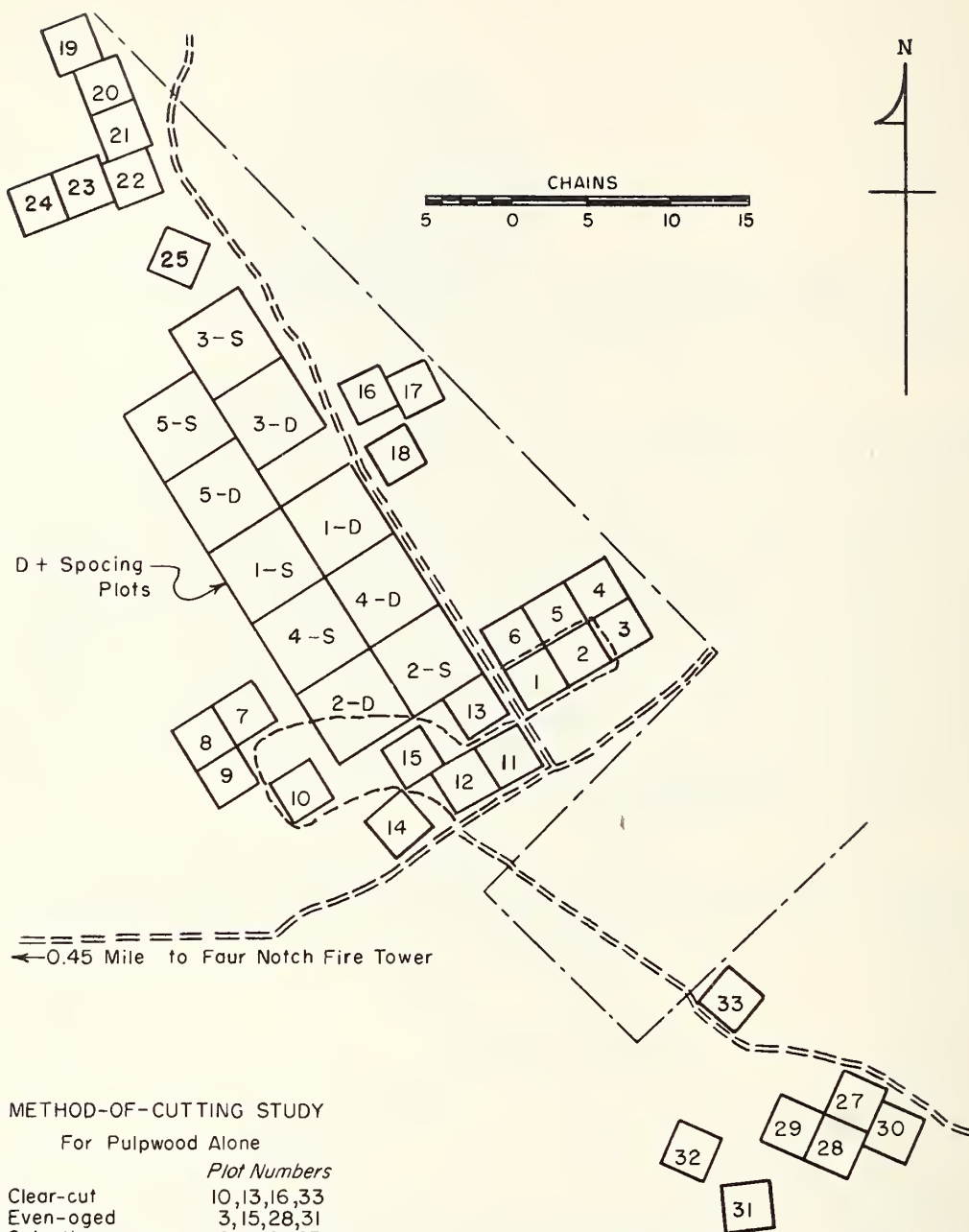
FOREWORD

The San Jacinto Experimental Forest is one of three experimental forests maintained by the East Texas Research Center of the Southern Forest Experiment Station. 1/

The 2,200-acre San Jacinto Experimental Forest, located in Walker County about 10 miles southeast of Huntsville, was set aside for research in 1937. A part of the Sam Houston National Forest, it is representative of the better timber stands to be found in the southeastern part of Texas. Following a very heavy cutting of the virgin timber about 1890, this area restocked to an essentially even-aged stand of shortleaf and loblolly pine. Loblolly makes up about 60 percent of the stand and shortleaf the remainder. Hardwoods are of low quality, and in the last few years most of the larger ones have been killed by girdling. The understory of shrubs and small hardwoods has become considerably more dense since 1935, when the area was put under fire protection. Previously fires had been frequent.

Timber cutting and other silvicultural measures on the San Jacinto Experimental Forest are accomplished under the supervision of the District Ranger, Raven Ranger District, Sam Houston National Forest.

1/ Studies in progress on the other forests are described in the "Guide to the East Texas Branch," available at Southern Forest Experiment Station headquarters in New Orleans, or at the East Texas Research Center, c/o Stephen F. Austin State College, Nacogdoches, Texas.



METHOD-OF-CUTTING STUDY

For Pulpwood Alone

	<i>Plot Numbers</i>
Clear-cut	10, 13, 16, 33
Even-aged	3, 15, 28, 31
Selection	6, 11, 21, 23
Pulpwood Assoc.	2, 7, 24, 32

For Sowlogs and Pulpwood

	<i>Plot Numbers</i>
5-yr. selection	1, 19, 22, 25
10-yr. selection	12, 14, 18, 30
15-yr. selection	4, 8, 17, 27
Shelterwood	5, 9, 20, 29

D+ SPACING STUDY

Date installed	D + Spacing	Selection
	<i>Plot Numbers</i>	
1950	1-D	1-S
1951	2-D	2-S
1952	3-D	3-S
1953	4-D	4-S
1954	5-D	5-S

EXPERIMENTAL PLOTS, SAN JACINTO EXPERIMENTAL FOREST.

THE SAN JACINTO EXPERIMENTAL FOREST

George K. Stephenson

Southern Forest Experiment Station

How to manage loblolly and shortleaf pines for maximum sustained yield is still an open question. The ultimate answer will be based on comparisons of average annual yield per acre from different methods over long periods. The problem is broad and has many different aspects, for it involves different cutting practices, management objectives, original stand conditions, sites, and localities. It cannot be solved in a single experiment but must be attacked in many studies.

Prior to 1954, two studies involving methods of managing pine forests were installed on the San Jacinto Experimental Forest. The earlier study, set up in 1938, compares eight methods of cutting pulpwood and sawlogs. In the second study, a cutting method based on relationships between spacing and tree diameter--the so-called D+ system--is being compared with the single-tree selection system. The first installation on this study was made in 1949.

This guide is especially designed for use in inspecting the studies on the ground. The location and treatment of the plots in both studies are shown on the map on the facing page. Plot corners are marked by treated wooden posts bearing aluminum identification tags which face the plot centers.

STAND DESCRIPTION

When the methods-of-cutting study began in 1938, the pine stand was about 45 years old. It contained an average of 7,416 board feet (International 1/4-inch rule) per acre in trees more than 9.5 inches in diameter at breast height, or 2,928 merchantable cubic feet (inside bark) per acre in trees more than 3.5 inches in d.b.h. On the average, loblolly made up about 60 percent of the stand, shortleaf 40 percent. There was an undergrowth of shrubs and small brush, but hardwoods more than 4 inches in d.b.h. were scarce. Twelve to 16 years later, when the D+ study was installed in a similar stand, volumes averaged 11,580 board feet per acre.

The site quality is about average for loblolly pine in east Texas. Site index (average height of dominant and codominant trees at 50 years) is mostly 75 to 80 feet, but ranges from about 70 to 85 feet.

METHODS-OF-CUTTING STUDY

Eight different cutting practices, involving two management objectives, are being tested. The 32 square 1-acre plots, 4 for each cutting practice, were located and cut in 1938 and remeasured and cut (as required) in 1943, 1948, and 1953. Measurements are confined to a half acre in the center of each plot.

The management objectives and cutting practices fall into two groups.

I. PULPWOOD PRODUCTION. The first group of 16 plots is being cut with the objective of producing pulpwood and small sawlogs, from trees not more than about 14 inches d.b.h.

Selection cutting, 10-year cutting cycle. --Regulated cuts averaging 31 percent of the total merchantable volume in 1938 and 33 percent in 1948 have been made. Each cut was taken from the trees of lowest vigor and those likely to increase least in volume. Practically all trees over 13 inches d.b.h. were cut because they were larger than is considered desirable for pulpwood. No attempt was made to make openings of any particular size. The ultimate objective is to create and maintain an all-aged forest with an optimum distribution of size classes.

Cutting to create or maintain an even-aged forest. --The stand in 1938 was essentially even-aged but contained a considerable range of diameters. The initial cutting left the stand well stocked with a narrow range of diameters such as would characterize an even-aged stand that had been thinned regularly. All trees of reasonably good form, quality, and vigor in the 8- to 13-inch d. b. h. classes, inclusive, were left in 1938; and all but a few of the very best smaller and larger trees were cut. In 1948, all trees more than 14.5 inches d. b. h. were cut, and smaller trees were left unless they seemed likely to die within 5 years. In 1953 a preparatory regeneration cut released about 10 potential seed trees per acre to encourage seed production. In addition, trees above 14.5 inches d. b. h. were cut as in previous operations to conform to the management objectives. On the average, 37 percent of the total merchantable volume was cut in 1938, 46 percent in 1948, and 38 percent in 1953. Plans are to remove all pines except the seed trees in 1958.

Pulpwood Association minimum practice cutting. --This is a test of the heaviest cutting permitted under the rules adopted by an association of Louisiana, Arkansas, and Texas pulp mills in 1937. All trees at least 7.0 inches d. b. h. (approximately 8 inches or more in diameter at a stump height of 12 inches) were cut in 1938. This cut averaged 93 percent of the total merchantable volume. An average of ninety-seven 4- to 7-inch trees per acre was left. Since the trees left had very small crowns and produced no seed immediately, early reproduction had to come from seed cast by trees outside the plots.

Clear cutting. --All trees containing at least two sticks of pulpwood were cut in 1938. Most of the trees too small to cut (less than 5 inches d. b. h.) were knocked down in logging. Seed for reproduction necessarily has come from trees outside the plots.

II. SAWLOG PRODUCTION. The second group of 16 plots is being handled with the objective of producing sawlogs from high-quality trees averaging at least 18 inches d. b. h. , with pulpwood coming only from thinnings and tops.

Selection cutting, 5-year cutting cycle. --Regulated cuts averaging 17 percent of the total merchantable volume in 1938, 11 percent in 1943, 22 percent in 1948, and 14 percent in 1953 have been made. Each cut was taken from the trees of lowest quality and vigor and those likely to increase least in value. Trees are taken entirely on their individual merits. There is no attempt to make openings of any particular size. The ultimate objective is to create and maintain an all-aged or selection forest with an optimum distribution of size classes.

Selection cutting, 10-year cutting cycle. --Same principles of marking as above. Regulated cuts averaging 28 percent of the total merchantable volume in 1938 and 32 percent in 1948 have been made.

Selection cutting, 15-year cutting cycle. --Same principles of marking as above. Regulated cuts averaging 42 percent of the total merchantable volume in 1938 and 45 percent in 1953 have been made.

Shelterwood cutting. --The cut in 1938 left only 24 to 34 trees per acre of the sawlog-size pines most desirable for seed production and for further growth and increase in value, plus a few high-quality smaller trees. An average of 80 percent of the total merchantable volume was removed. Ten to twenty reserved trees per acre were more than 11 inches d.b.h. All reserved trees will be cut after adequate reproduction has become established. Reproduction was adequate on three of the four plots in 1948, but the reserved trees will be left until 1958 to determine their effect on survival and growth of the reproduction.

Hardwood Control

In 1938, all hardwoods above 8.5 inches d.b.h. were cut or girdled. A second control treatment in February 1954 deadened all hardwoods, regardless of size, which were interfering with the growth of pines. In this operation the larger hardwoods were girdled and the smaller ones were cut down. The small stumps were treated with Ammate crystals to prevent sprouting.

Results through 1953

Though qualified by the conditions under which the study was made, early results from these plots show how certain unmanaged stands react to widely different cutting practices in conversion to various systems of management. They also indicate practices that are suitable or likely to prove best for given management objectives. Cutting practices that seem especially promising on these plots, together with modifications of such practices, are now being tested on a much larger scale on the Kurth Tract near Nacogdoches.

Average volumes cut and left and average net annual growth for each cutting method are given in table 1. Pine reproduction is summarized in table 2. Table 3 shows numbers of trees and volumes cut and left on each plot. In brief, the main results to date are:

1. Average annual net growth in 15 years has been highest in the even-aged pulpwood plots. These have produced 400 board feet of sawtimber and 58 cubic feet of total growth per year. The clear-cut plots, the least productive in the study, averaged 33 cubic feet of growth annually. In terms of sawtimber growth, the Pulpwood Association minimum-practice plots and the clear-cut plots, with 96 and 11 board feet of annual production, average much lower than those that have been cut less severely.

Table 1. --Average volumes cut and left, and average annual net growth per acre, 1938-53

Method of cutting	Residual stand 1938	Cut 1943	Residual stand 1943	Cut 1948	Residual stand 1948	Cut 1953	Residual stand 1953	Average annual net growth 1938-53	
MERCHANTABLE CUBIC VOLUME ^{1/}									
	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Pct. ^{2/}
For pulpwood									
10-year Selection	1, 883	0	2, 153	809	1, 631	0	1, 690	41	2. 1
Even-aged	1, 780	0	2, 145	1, 183	1, 370	557	905	58	3. 1
Pulpwood Association minimum practice	220	0	347	0	626	0	909	46	12. 2
Clear-cut	0	0	0	0	224	0	500	33	35. 3
For sawlogs									
5-year Selection	2, 480	320	2, 477	592	2, 085	313	1, 864	41	1. 6
10-year Selection	1, 847	0	2, 131	801	1, 727	0	1, 777	49	2. 5
15-year Selection	1, 960	0	2, 302	0	2, 665	1, 252	1, 505	53	2. 5
Shelterwood	668	0	853	0	1, 035	0	1, 229	37	4. 5
MERCHANTABLE BOARD-FOOT VOLUME ^{3/}									
	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Pct. ^{2/}
For pulpwood									
10-year Selection	5, 334	0	7, 052	3, 645	5, 270	0	6, 376	313	5. 3
Even-aged	5, 565	0	8, 038	5, 602	5, 148	2, 457	3, 501	400	6. 2
Pulpwood Association minimum practice	0	0	26	0	386	0	1, 446	96	112. 4
Clear-cut	0	0	0	0	51	0	173	11	15. 7
For sawlogs									
5-year Selection	7, 898	1, 257	8, 677	2, 567	8, 067	1, 520	7, 148	306	3. 7
10-year Selection	6, 820	0	8, 642	3, 637	7, 292	0	7, 958	318	4. 1
15-year Selection	6, 323	0	8, 374	0	10, 594	5, 905	5, 626	347	4. 5
Shelterwood	2, 696	0	3, 802	0	4, 696	0	5, 371	178	5. 3

^{1/} Volume inside bark to a merchantable pulpwood top diameter (not less than 3 inches inside bark) for all pine trees with d. b. h. larger than 3.5 inches.

^{2/} Average of three 5-year growth periods with different bases.

^{3/} Volume inside bark to a merchantable sawlog top diameter (not less than 6 inches inside bark) for all pine trees with d. b. h. larger than 9.5 inches. Volume is expressed in board feet in accordance with the International log rule with 1/4-inch kerf.

2. Percentagewise, growth rates have averaged highest under the practices that left lowest residual growing stocks --clear-cutting and Pulpwood Association minimum-practice. Growth on those plots is largely on young trees, many of which are present only because of abundant seed production outside the plots. Cutting systems which left sizeable growing stocks have averaged from 1.6 to 4.5 percent growth in total cubic volume, and from 3.7 to 6.1 percent in board feet.
3. Two classes of plots grew faster in 1948-53 than in earlier periods. These were the clear-cut plots and those cut to Pulpwood Association minimum standards--on both series, the growing stock is mostly young. The shelterwood plots, in which a large part of the growth is on young trees, showed an increase in cubic-foot growth but a decline in board-foot growth. All other plots declined in both cubic- and board-foot growth and in growth percent.
4. Heavy mortality from insects, logging damage, ice storms, and droughts was responsible for a considerable part of the reduction in growth rate during the 1948-53 period. On some plots mortality exceeded gross growth. For the study as a whole, the sum of net growth plus mortality was less than the net growth alone in the previous five years.
5. Most of the heavily cut areas, including three of the four shelterwood plots, were satisfactorily restocked with young pine shortly after the original cuttings in 1938. It is doubtful if the clear-cutting and Pulpwood Association plots could have reseeded successfully had they not been surrounded by stands which afforded abundant seed.
6. Success of reproduction on the selection plots was uncertain in 1953. Little pine reproduction had become established following the 1938 and 1943 cuttings. Seedlings from the 1951 seed crop were present in 1953 in many openings created by the 1948 cuttings. These seedlings had survived the 1952 drought, but their eventual survival was not yet assured.
7. Growth of hardwood trees and brush on the study area during the 15-year period demonstrated that none of the cutting systems was capable of maintaining pure pine stands without supplemental hardwood control measures.

Table 2. --Prevalence of reproduction by methods of cutting, 1948 and 1953

Method of cutting	Milacres stocked							
	Total		Pines at least 2 years old		Pines more than 3.5 feet high		Pines more than 7.5 feet high	
	1948	1953	1948	1953	1948	1953	1948	1953
----- Percent -----								
<u>For pulpwood</u>								
10-year Selection	15	29	13	6	1	1	0	0
Even-aged	13	48	11	16	4	10	2	7
Pulpwood Association minimum practice	71	62	69	53	50	49	35	44
Clear-cut	64	41	60	27	54	27	43	1/24
<u>For sawlogs</u>								
5-year Selection	18	45	9	1	0	0	0	0
10-year Selection	27	52	21	20	8	13	5	7
15-year Selection	49	32	48	24	11	11	2	4
Shelterwood	70	64	67	58	55	57	31	52

1/ If milacres bearing trees 3.6 to 9.5 inches d. b. h. were included, percentage would be 40.

In appraising the results on the methods-of-cutting plots, several points should be kept in mind: (1) The plots are small; hence yield may be unduly affected by abnormal behavior of relatively few trees. Nor does all the seed shed on a given plot necessarily come from trees on the plot. (2) Before cutting in 1938, the plots varied considerably in volume, in diameter and crown-class distribution, and in the proportion of loblolly and shortleaf pines. (3) The cutting practices under test were begun in an essentially even-aged stand that had grown for about 45 years without any management. Hence the selection cuttings must be repeated many times before the stands can be converted to an ideal or all-aged form. The other types of cutting also would presumably have produced better results if they had been made in well-managed, even-aged stands. Moreover, comparisons of yields from all-aged and even-aged management are likely to be misleading unless based on a complete rotation. (4) The period 1948-53 included four seasons of subnormal rainfall and several prolonged growing-season droughts.

Table 3.--Number of trees, volume, and volume growth per acre on individual plots: Selection cut for pulpwood

Pine stand	Plot 6			Plot 11			Plot 21			Plot 23		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
Left, 1938	186	1,548	...	172	2,036	...	228	2,185	...	216	1,764	...
Present in 1943 (no cutting)	176	1,787	...	162	2,370	...	220	2,470	...	208	2,004	...
Average annual net growth, 1938-43		48	3.0		67	3.3		57	2.6		48	2.7
Before cut, 1948	164	2,120	100.0	156	2,633	100.0	212	2,766	100.0	182	2,241	100.0
Cut, 1948	28	791	37.0	48	1,077	41.0	30	684	25.0	26	683	30.0
Left, 1948	136	1,329	63.0	108	1,556	59.0	182	2,082	75.0	156	1,558	70.0
Average annual net growth, 1943-48		67	3.7		53	2.2		59	2.4		47	2.4
Present in 1953 (no cutting)	114	1,378	...	92	1,653	...	162	2,080	...	142	1,649	...
Average annual net growth, 1948-53		10	0.7		19	1.2		0	0.0		18	1.2
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
Left, 1938	54	4,224	...	82	6,488	...	74	5,990	...	56	4,636	...
Present in 1943 (no cutting)	62	5,606	...	92	8,570	...	88	7,870	...	70	6,140	...
Average annual net growth, 1938-43		276	6.5		416	6.4		376	6.3		301	6.5
Before cut, 1948	76	7,982	100.0	92	10,118	100.0	92	9,534	100.0	78	8,026	100.0
Cut, 1948	22	3,756	47.0	30	4,578	45.0	20	3,024	32.0	20	3,224	40.0
Left, 1948	54	4,226	53.0	62	5,540	55.0	72	6,510	68.0	58	4,802	60.0
Average annual net growth, 1943-48		475	8.5		310	3.6		333	4.2		377	6.1
Present in 1953 (no cutting)	56	4,898	...	66	6,828	...	76	8,134	...	58	5,646	...
Average annual net growth, 1948-53		134	3.2		258	4.7		325	5.0		169	3.5

Table 3.--(Continued): Even-aged for pulpwood

Pine stand	Plot 3			Plot 15			Plot 28			Plot 31		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
Left, 1938	140	1,684	...	132	1,460	...	110	1,692	...	178	2,286	...
Present in 1943 (no cutting)	134	2,045	...	130	1,737	...	112	2,071	...	166	2,729	...
Average annual net growth, 1938-43		72	4.3		55	3.8		76	4.5		89	3.9
Before cut, 1948	126	2,404	100.0	128	1,950	100.0	106	2,450	100.0	172	3,408	100.0
Cut, 1948	26	885	37.0	30	784	40.0	40	1,397	57.0	50	1,667	49.0
Left, 1948	100	1,519	63.0	98	1,166	60.0	66	1,053	43.0	122	1,741	51.0
Average annual net growth, 1943-48		72	3.5		43	2.5		76	3.7		136	5.0
Before cut, 1953	96	1,738	100.0	86	1,192	100.0	60	1,186	100.0	106	1,733	100.0
Cut, 1953	18	531	31.0	22	451	38.0	22	561	47.0	32	685	39.0
Left, 1953	78	1,207	69.0	64	741	62.0	38	625	53.0	74	1,048	61.0
Average annual net growth, 1948-53		44	2.9		5	.4		27	2.6		-2	-.1
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
Left, 1938	54	4,478	...	60	4,496	...	64	5,968	...	84	7,318	...
Present in 1943 (no cutting)	80	7,032	...	70	6,542	...	78	8,176	...	102	10,410	...
Average annual net growth, 1938-43		511	11.4		409	9.1		442	7.4		618	8.5
Before cut, 1948	98	9,858	100.0	80	8,108	100.0	90	10,842	100.0	120	14,192	100.0
Cut, 1948	26	4,254	43.0	26	3,622	45.0	40	6,716	62.0	44	7,816	55.0
Left, 1948	72	5,604	57.0	54	4,486	55.0	50	4,126	38.0	76	6,376	45.0
Average annual net growth, 1943-48		565	8.0		313	4.8		533	6.5		756	7.3
Before cut, 1953	76	7,176	100.0	54	4,934	100.0	48	4,998	100.0	70	6,726	100.0
Cut, 1953	18	2,470	34.0	22	2,044	41.0	20	2,562	51.0	24	2,754	41.0
Left, 1953	58	4,706	66.0	32	2,890	59.0	28	2,436	49.0	46	3,972	59.0
Average annual net growth, 1948-53		314	5.6		90	2.0		174	4.2		70	1.1

Table 3.--(Continued): Pulpwood Association minimum practice

Pine stand	Plot 2			Plot 7			Plot 24			Plot 32		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
All trees over 3.5 inches d.b.h.												
Left, 1938	80	224	...	96	226	...	86	171	...	124	261	...
Present in 1943 (no cutting)	82	347	...	84	365	...	86	242	...	128	473	...
Average annual net growth, 1938-43		25	11.0		28	12.3		14	8.3		42	16.2
Present in 1948 (no cutting)	80	604	...	136	654	...	80	402	...	152	845	...
Average annual net growth, 1943-48		51	14.8		58	15.8		32	13.2		74	15.7
Present in 1953 (no cutting)	90	834	...	186	1,037	...	96	572	...	212	1,194	...
Average annual net growth, 1948-53		46	7.6		77	11.8		34	8.4		70	8.3
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
All trees over 9.5 inches d.b.h.												
Left, 1938	0	0	...	0	0	...	0	0	...	0	0	...
Present in 1943 (no cutting)	0	0	...	2	102	...	0	0	...	0	0	...
Average annual net growth, 1938-43		0	...		20	...		0	...		0	...
Present in 1948 (no cutting)	2	146	...	6	394	...	4	204	...	14	802	...
Average annual net growth, 1943-48		29	...		58	57.3		41	...		160	...
Present in 1953 (no cutting)	30	1,754	...	28	1,750	...	10	598	...	26	1,682	...
Average annual net growth, 1948-53		322	220.5		271	68.8		79	38.7		176	21.9

Table 3.--(Continued): Clear-cut for pulpwood

Pine stand	Plot 10			Plot 13			Plot 16			Plot 33		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
All trees over 3.5 inches d.b.h.												
Left, 1938	0	0	...	0	0	...	0	0	...	0	0	...
Present in 1943 (no cutting)	18	38	...	34	41	...	8	12	...	40	87	...
Average annual net growth, 1938-43		8	...		8	...		2	...		17	...
Present in 1948 (no cutting)	160	251	...	192	249	...	78	111	...	110	285	...
Average annual net growth, 1943-48		43	112.1		42	101.5		20	165.0		40	45.5
Present in 1953 (no cutting)	276	592	...	328	530	...	198	391	...	160	486	...
Average annual net growth, 1948-53		68	27.1		56	22.5		56	50.4		40	14.0
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
All trees over 9.5 inches d.b.h.												
Left, 1938	0	0	...	0	0	...	0	0	...	0	0	...
Present in 1943 (no cutting)	0	0	...	0	0	...	0	0	...	0	0	...
Average annual net growth, 1938-43		0	...		0	...		0	...		0	...
Present in 1948 (no cutting)	0	0	...	0	0	...	0	0	...	4	204	...
Average annual net growth, 1943-48		0	...		0	...		0	...		41	...
Present in 1953 (no cutting)	2	102	...	2	102	...	0	0	...	6	490	...
Average annual net growth, 1948-53		20	...		20	...		0	...		57	27.9

Table 3.--(Continued): 5-year selection for sawlogs

Pine stand	Plot 1			Plot 19			Plot 22			Plot 25		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
All trees over 3.5 inches d.b.h.												
Left, 1938	140	2,204	...	266	2,050	...	274	2,618	...	224	3,050	...
Before cut, 1943	138	2,499	100.0	248	2,329	100.0	258	2,952	100.0	218	3,410	100.0
Cut, 1943	16	253	10.0	18	204	9.0	22	379	13.0	14	444	13.0
Left, 1943	122	2,246	90.0	230	2,125	91.0	236	2,573	87.0	204	2,966	87.0
Average annual net growth, 1938-43		59	2.7		56	2.7		67	2.6		72	2.4
Before cut, 1948	108	2,450	100.0	214	2,329	100.0	206	2,749	100.0	170	3,177	100.0
Cut, 1948	14	484	20.0	30	366	16.0	32	467	17.0	30	1,050	33.0
Left, 1948	94	1,966	80.0	184	1,963	84.0	174	2,282	83.0	140	2,127	67.0
Average annual net growth, 1943-48		41	1.8		41	1.9		35	1.4		42	1.4
Before cut, 1953	82	2,018	100.0	164	2,149	100.0	158	2,407	100.0	114	2,133	100.0
Cut, 1953	4	312	16.0	6	259	12.0	10	340	14.0	12	340	16.0
Left, 1953	78	1,706	84.0	158	1,890	88.0	148	2,067	86.0	102	1,793	84.0
Average annual net growth, 1948-53		10	.5		37	1.9		25	1.1		1	...
All trees over 9.5 inches d.b.h.												
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
Left, 1938	72	8,256	...	64	4,816	...	80	7,336	...	78	11,184	...
Before cut, 1943	90	10,402	100.0	86	6,566	100.0	98	9,670	100.0	86	13,096	100.0
Cut, 1943	12	910	9.0	10	646	10.0	14	1,462	15.0	10	2,008	15.0
Left, 1943	78	9,492	91.0	76	5,920	90.0	84	8,208	85.0	76	11,088	85.0
Average annual net growth, 1938-43		429	5.2		350	7.3		467	6.4		382	3.4
Before cut, 1948	76	10,930	100.0	88	7,596	100.0	94	9,988	100.0	80	12,940	100.0
Cut, 1948	12	2,266	21.0	14	1,272	17.0	14	1,744	17.0	24	4,984	39.0
Left, 1948	64	8,664	79.0	74	6,324	83.0	80	8,244	83.0	56	7,956	61.0
Average annual net growth, 1943-48		288	3.0		335	5.7		356	4.3		370	3.3
Before cut, 1953	58	8,960	100.0	84	7,622	100.0	78	9,372	100.0	54	8,718	100.0
Cut, 1953	4	1,638	18.0	6	1,326	17.0	8	1,596	17.0	10	1,520	17.0
Left, 1953	54	7,322	82.0	78	6,296	83.0	70	7,776	83.0	44	7,198	83.0
Average annual net growth, 1948-53		59	.7		260	4.1		226	2.7		152	1.9

Table 3.--(Continued): 10-year selection for sawlogs

Pine stand	Plot 12			Plot 14			Plot 18			Plot 30		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
All trees over 3.5 inches d.b.h.												
Left, 1938	166	1,894	...	108	1,493	...	132	2,229	...	154	1,772	...
Present in 1943 (no cutting)	150	2,108	...	98	1,833	...	128	2,635	...	142	1,946	...
Average annual net growth, 1938-43		43	2.3		68	4.6		81	3.6		35	2.0
Before cut, 1948	144	2,532	100.0	88	2,227	100.0	128	2,980	100.0	146	2,373	100.0
Cut, 1948	40	1,049	41.0	16	554	25.0	32	1,079	36.0	28	520	22.0
Left, 1948	104	1,483	59.0	72	1,673	75.0	96	1,901	64.0	118	1,853	78.0
Average annual net growth, 1943-48		85	4.0		79	4.3		69	2.6		85	4.4
Present in 1953 (no cutting)	78	1,279	...	64	1,734	...	82	2,112	...	102	1,982	...
Average annual net growth, 1948-53		-41	-2.8		12	.7		42	2.2		26	1.4
All trees over 9.5 inches d.b.h.												
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
Left, 1938	58	6,616	...	66	5,754	...	70	8,574	...	68	6,336	...
Present in 1943 (no cutting)	66	8,454	...	58	7,762	...	80	10,954	...	70	7,400	...
Average annual net growth, 1938-43		368	5.6		402	7.0		476	5.6		213	3.4
Before cut, 1948	72	10,766	100.0	62	9,920	100.0	88	13,030	100.0	80	10,004	100.0
Cut, 1948	26	4,692	44.0	14	2,626	26.0	26	5,136	39.0	16	2,096	21.0
Left, 1948	46	6,074	56.0	48	7,294	74.0	62	7,894	61.0	64	7,908	79.0
Average annual net growth, 1943-48		462	5.5		432	5.6		415	3.8		521	7.0
Present in 1953 (no cutting)	34	5,322	...	48	8,076	...	64	9,624	...	60	8,810	...
Average annual net growth, 1948-53		-150	-2.5		156	2.1		346	4.4		180	2.3

Table 3.--(Continued): 15-year selection for sawlogs

Pine stand	Plot 4			Plot 8			Plot 17			Plot 27		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
All trees over 3.5 inches d.b.h.												
Left, 1938	186	1,887	...	126	2,080	...	166	1,960	...	162	1,912	...
Present in 1943 (no cutting)	182	2,252	...	124	2,503	...	160	2,304	...	158	2,149	...
Average annual net growth, 1938-43		73	3.9		85	4.1		69	3.5		47	2.5
Present in 1948 (no cutting)	180	2,725	...	130	2,896	...	150	2,644	...	142	2,395	...
Average annual net growth, 1943-48		95	4.2		79	3.1		68	3.0		49	2.3
Before cut, 1953	178	2,827	100.0	126	3,154	100.0	134	2,668	100.0	124	2,379	100.0
Cut, 1953	40	1,128	40.0	56	1,848	59.0	34	1,108	41.0	34	924	39.0
Left, 1953	138	1,699	60.0	70	1,306	41.0	100	1,560	59.0	90	1,455	61.0
Average annual net growth, 1948-53		20	.7		49	1.7		5	.2		-3	-.1
All trees over 9.5 inches d.b.h.												
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
Left, 1938	62	5,320	...	70	7,820	...	52	6,058	...	68	6,094	...
Present in 1943 (no cutting)	80	7,442	...	84	10,408	...	66	7,966	...	74	7,682	...
Average annual net growth, 1938-43		424	8.0		518	6.6		382	6.3		318	5.2
Present in 1948 (no cutting)	94	10,150	...	90	12,614	...	76	10,066	...	82	9,546	...
Average annual net growth, 1943-48		542	7.3		441	4.2		420	5.3		373	4.9
Before cut, 1953	102	10,950	100.0	94	14,230	100.0	72	10,952	100.0	78	9,994	100.0
Cut, 1953	38	5,294	48.0	52	8,768	62.0	24	5,150	47.0	34	4,410	44.0
Left, 1953	64	5,656	52.0	42	5,462	38.0	48	5,802	53.0	44	5,584	56.0
Average annual net growth, 1948-53		160	1.6		323	2.6		177	1.7		90	.9

Table 3.--(Continued): Shelterwood

Pine stand	Plot 5			Plot 9			Plot 20			Plot 29		
	Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.		Trees	Merch. vol.	
	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.	No.	Cu.ft.	Pct.
All trees over 3.5 inches d.b.h.												
Left, 1938	42	648	...	46	880	...	52	604	...	56	539	...
Present in 1943 (no cutting)	44	813	...	40	1,102	...	60	810	...	64	688	...
Average annual net growth, 1938-43		33	5.1		44	5.0		41	6.8		30	5.5
Present in 1948 (no cutting)	58	910	...	48	1,296	...	54	1,002	...	62	934	...
Average annual net growth, 1943-48		19	2.4		39	3.5		38	4.7		49	7.2
Present in 1953 (no cutting)	130	1,143	...	90	1,525	...	68	1,109	...	72	1,138	...
Average annual net growth, 1948-53		47	5.2		46	3.5		21	2.1		41	4.4
All trees over 9.5 inches d.b.h.												
	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.	No.	Bd.ft.	Pct.
Left, 1938	32	2,570	...	32	3,858	...	22	2,256	...	20	2,102	...
Present in 1943 (no cutting)	36	3,606	...	32	5,200	...	30	3,490	...	24	2,914	...
Average annual net growth, 1938-43		207	8.1		268	7.0		247	10.9		162	7.7
Present in 1948 (no cutting)	32	4,134	...	32	6,186	...	32	4,554	...	24	3,910	...
Average annual net growth, 1943-48		106	2.9		197	3.8		213	6.1		199	6.8
Present in 1953 (no cutting)	34	4,980	...	32	7,114	...	32	4,986	...	26	4,402	...
Average annual net growth, 1948-53		169	4.1		186	3.0		86	1.9		98	2.5

STUDY OF CUTTING TO D+ SPACING

This study compares a conventional selection-cutting system on a 5-year cycle with a system of management based on successive thinnings and removal of crop trees at stated intervals. The thinning system derives its name, D+ spacing, from the basic concept that the distance between trees, in feet, should equal the diameter of the average tree in inches plus a constant, which in this case is 6. In addition, the system calls for harvesting an average of one crop tree per acre each year.

The objective of the study is to compare the amount and quality of timber produced and the types of stands developed under the two methods. Five pairs of 2-1/2-acre plots have been installed, the first pair before the 1950 growing season and an additional pair each succeeding winter through 1954. One plot of each pair was cut by the selection system, the other thinned by the D+ method. Following these cuttings, hardwoods on all plots were controlled by girdling those above 5 inches d. b. h. and felling and applying Ammate to the stumps of smaller ones.

Each pair of plots will be remeasured at 5-year intervals, at which time additional cutting will be done.

Under the D+ system all crowded parts of the stand were thinned by removing enough trees so that average spacing (in feet) equalled the average diameter of trees left (in inches) plus 6. In this initial cut, only one large tree per acre was cut as a crop tree, but in future cuts, crop trees will be removed at the average rate of one per acre per year. Regeneration of the stand is expected to occur primarily in the areas from which crop trees are removed.

Selection cuttings followed the principles applied on the 5-year selection plots of the methods-of-cutting study. A volume equal to the estimated growth in the next 5 years was cut from trees of lowest quality and with the least promise of increasing in value. As on the D+ plots, similar cuts will be removed at 5-year intervals.

Table 4 shows the number and volume of trees removed in the initial cuts on each plot, together with the original and residual stands.

No measurements of comparative growth had been made at the time of the final installation cut in 1954. A fair to good stand of pine reproduction dating from the 1951 seed crop had become established in larger openings in plots cut prior to 1953. Reproduction was generally

Table 4. --Number and volumes per acre of pine trees in original stands, removed in initial cuts, and left as growing stock on plots of D+ spacing study

Plot number ^{1/}	Installed	Original stand				Removed in initial cut				Residual stand			
		Trees 3.5+ inches d.b.h.		Trees 9.5+ inches d.b.h.		Trees 3.5+ inches d.b.h.		Trees 9.5+ inches d.b.h.		Trees 3.5+ inches d.b.h.		Trees 9.5+ inches d.b.h.	
		No.	Cu.ft.	No.	Bd.ft.	No.	Cu.ft.	No.	Bd.ft.	No.	Cu.ft.	No.	Bd.ft.
1-S	1950	165	2,242	78	8,717	60	622	18	2,074	105	1,620	60	6,643
1-D	1950	146	2,765	81	11,620	56	768	23	2,756	90	1,997	58	8,864
2-S	1951	119	2,459	69	10,650	40	647	17	2,633	79	1,812	52	8,017
2-D	1951	129	2,846	76	12,554	46	557	11	1,806	83	2,289	65	10,748
3-S	1952	158	3,186	84	13,224	57	1,073	22	4,470	101	2,113	62	8,754
3-D	1952	165	2,887	83	11,800	70	756	16	2,583	95	2,131	67	9,217
4-S	1953	130	2,584	70	11,165	45	911	20	3,875	85	1,673	50	7,290
4-D	1953	129	2,565	76	11,030	42	763	19	3,104	87	1,802	57	7,926
5-S	1954	187	3,547	109	14,583	72	1,223	37	4,774	115	2,324	72	9,809
5-D	1954	185	2,674	81	10,458	42	545	11	1,916	143	2,129	70	8,542
Average selection sub-plots		152	2,804	82	11,668	55	895	23	3,565	97	1,908	59	8,103
Average D+ sub-plots		151	2,747	79	11,492	51	678	16	2,433	100	2,070	63	9,059

^{1/} Plots with "S" in identification number are assigned to selection treatment. Plots with "D" are cut to D + 6 spacing.

absent from plots 4 and 5, which were not cut until after the 1951 seedlings had been lost during the 1952 drought.

Foresters of the Soil Conservation Service cooperated in the planning of the D+ spacing study and are assisting in its maintenance.



